# Hubble Space Telescope

# Wide Field Camera 3

Capabilities and Scientific Programs

WFC3 Scientific Oversight Committee
and
WFC3 Science Integrated Product Team

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# 1. Executive Summary

The Wide Field Camera 3 (WFC3) will be installed on the *Hubble Space Telescope* (HST) during Servicing Mission 4 in 2003. It is designed to ensure that the superb imaging performance of HST is maintained through the end of the mission. WFC3 takes advantage of recent developments in detector technology to provide new and unique capabilities for HST. Its ultraviolet/optical and near-infrared channels offer high sensitivity and wide field of view over the broadest wavelength range of any HST instrument. In the near-ultraviolet, its combination of field size and sensitivity outperforms earlier instruments by a factor of eight. In the near-infrared, it will be a factor of fifteen more capable than the earlier HST NICMOS instrument, and it offers a potent combination of resolution, field size, wavelength coverage, sensitivity, and photometric precision, which cannot easily be matched by even the largest ground-based telescopes.

WFC3's panchromatic performance allows it to address a number of major problems within NASA's Origins theme better than any previous instrument on HST. These include establishing the star-formation history of nearby galaxies, following the assembly of galaxies during the period of peak star formation and metal production activity 8-12 billion years ago, searching for the "End of the Dark Ages" - the high-redshift transition between the neutral and ionized epochs of the universe, exploring the birth and death of stars, and studying water and ices on Mars and the satellites of the outer planets. WFC3, with its superior sensitivity, spatial resolution, and wavelength coverage, will be a key instrument in exploiting the rich territory revealed by upcoming NASA ultraviolet and near-infrared missions, and by large ground-based visible and infrared surveys.

The design of WFC3 has been reviewed and endorsed by over 80 senior members of the astronomical community on seven different advisory panels. An Integrated Product Team representing a partnership between NASA Goddard Space Flight Center, the Space Telescope Science Institute, the Jet Propulsion Laboratory, and industry, is responsible for the design, fabrication, and testing of WFC3. A Scientific Oversight Committee of 21 members provides scientific guidance.

# 2. Introduction

A primary legacy of the *Hubble Space Telescope* (HST), both scientifically and in the public eye, will be the spectacular images it produces of the astronomical sky. Its cameras have been among the most productive instruments in the history of astronomy. As HST begins a second decade of operations, its superb imaging performance must continue to be maintained. Accordingly, a new high-performance, panchromatic camera, the *Wide Field Camera 3* (hereafter WFC3), is being developed for installation on HST during Servicing Mission 4, planned for 2003.

Three main drivers have inspired the current design of WFC3: (1) WFC3 must be able to offer excellent visible-band imaging performance which will endure until the end of the HST mission; (2) in order to address a wide variety of astrophysical questions and greatly expand HST's imaging capabilities, WFC3 should provide high sensitivity and large field of view (FOV) in the near-UV and near-IR bands; (3) as a pathfinder for NGST, WFC3 will help refine the questions that NGST will answer by providing complementary UV data and the highest near-IR sensitivity available before NGST. Although it builds on components and designs from the original WF/PC, ACS, and NICMOS, WFC3 has been able to take advantage of recent developments in both UV-visible and near-infrared detector technology to provide it with high sensitivity from 2000 to 17000 Å. This ***panchromatic*** capability makes WFC3 a unique instrument in addressing questions in three of NASA's Origins themes: The Distant Universe; Galaxies and the Nearby Universe; and Stars and Planets.

WFC3 will be the only HST scientific instrument to have been developed as a "facility instrument." That is, it was not proposed by a Principal Investigator and will not be built by an Investigation Definition Team (IDT) to answer a specific set of scientific questions. In place of an Instrument IDT, WFC3 is being designed and built by an Integrated Product Team (IPT) that includes personnel from the NASA Goddard Space Flight Center, the Space Telescope Science Institute, the Jet Propulsion Laboratory, and industry. A Scientific Oversight Committee (SOC) of 21 members was selected on the basis of community solicitation to advise the HST Senior Scientist at the NASA Goddard Space Flight Center (GSFC) and the STScI Director, and to provide broad scientific direction and guidance to the WFC3 project.

WFC3 is the product of a community consensus that HST's imaging capabilities needed to be safeguarded and enhanced in the second decade of HST life. Reviews by advisory committees, including over 80 astronomers, reflect this consensus. In 1996, the *HST and Beyond* study, chaired by A. Dressler, recommended that HST should continue to be operated as an "essential astronomical tool throughout the first decade of the next century." In 1998, the HST Project re-convened the original Instrument Peer Review panel that reviewed instrument proposals for Servicing Mission 4, to discuss the best way to ensure continued imaging capability until the HST end of mission. The panel strongly endorsed the plan to build WFC3 and install it in the telescope during Servicing Mission 4. The initial plan was for a CCD camera to operate in the visible/ultraviolet 2000 - 10000 Å spectral region. The *HST Second Decade* study panel, chaired by R. Brown, recommended that the WFC3 project consider taking advantage of the rapid improvement in IR detector technology by adding an infrared channel to cover the 9000-17000 Å spectral region. This proposal received the strong endorsement of the WFC3 Scientific Oversight

Committee, the Cycle 8 HST Time Allocation Committee, the Space Telescope Institute Council, the Space Telescope Users Committee, and the Origins Sub-Committee.

This document is a joint effort by the SOC and the WFC3 IPT to present the scientific rationale for the capabilities of WFC3. In particular, it defines the role of WFC3 as a scientific instrument aboard HST, delineates the major astronomical regimes it will explore, and shows how these have led to the final instrument design and characteristics.